present invention are effectively sonicated with piezoelectric devices that consume less than ten watts, and a particular apparatus functions with a piezoelectric device consuming approximately 0.25 watts. A preferred piezoelectric device is a piston-mass device.

[0050] It was further discovered that structural coupling of sonicating energy from a sonication generator to a cell containing assay materials is a remarkably efficient design. The most effective structural coupling has proven to be solid contact, e.g. by direct attachment of the sonication generator to the cell or attachment of the sonication generator so that a solid continuum is provided between the sonication generator and the assay cell. By specifically transmitting sonication energy to the assay cell or to a solid-phase support in the assay cell, much less energy is needed as compared to inducing an entire apparatus to sonicate. Careful positioning of the sonication generator allows focused direction of the energy of the contents of the assay cell and lessens the effects of damping by other elements of an assay system. Structural coupling may be reversible (e.g. the sonication generator and the cell may be designed to be connected and unconnected multiple times) or may represent a permanent connection.

[0051] It is to be understood that structural coupling of sonication energy can be achieved with many different types of configurations. The structural coupling of sonication energy specifically encompasses the transmission of sonication energy (a) through a solid interface between a sonication generator and an assay medium or binding surface; or (b) from a sonication generator directly to an assay medium or to a binding surface.

[0052] It is an important advantage of the present invention that the structural coupling of sonication energy in apparatus according to the present invention can be precisely controlled. Such control of the structural coupling mechanism is readily implemented through precise control of the manufacturing apparatus components and the assembly of same. Each component of the structural coupling mechanism, e.g. the sonication generator, the diaphragm, etc., can be manufactured to precise tolerances. Similarly, the structural coupling mechanism is suitable for precise assembly permitting the construction of multiple apparatuses having virtually identical sonication transmission characteristics. Preferably, sonication assay cells manufactured to precise tolerances use components comprising rigid materials.

[0053] The present invention is generally applicable to binding assay systems such as immunoassays, nucleic acid hybridization assays, receptor-ligand binding assays, and the like. Further assays in which the present invention is advantageously employed includes assays that involve the direct detection of an analyte, detection through a competitive binding reaction, or indirect detection, such as sandwich immunoassays, sandwich nucleic acid hybridization assays, detection of enzymatic products and detection of amplification products. Such assays may be homogeneous or heterogeneous and may or may not incorporate a wash step. The present invention is suitable for use with a variety of techniques used to detect binding events, such as ELISA, fluorescence, chemiluminescence, RIA, scintillation proximity, direct optical detection (e.g., SPR), electrochemical detection, and electrochemiluminescence. It has been found that assay systems like these are particularly responsive to sonication directly structurally coupled to the assay cell or to the assay medium. In assays where binding reactions occur in the vicinity of an electrode, sonication of the electrode itself has proven to have an especially beneficial effect in increasing assay reaction rates.

[0054] As will be understood by one of ordinary skill in the art, FIGS. **1-7** present simplified cross-sectional diagrams illustrating different assay cell designs that embody principles and useful applications of the present invention. To facilitate concise explanation but wide-ranging application, particular assay cell features and elements needed to perform specific types of assays have been omitted in some or all of the figures. The drawings, and features depicted therein, are not necessarily drawn to scale. Moreover, to further facilitate explanation of the present invention, certain features of the present invention shown in the drawings have been enlarged or reduced in size relative to other features in the same or other drawings.

[0055] In addition, description and illustration of specific electrical connections for, and mechanical couplings among, assay cell elements have been omitted to simplify the drawings. The assay cells presented may be incorporated into larger assay device systems or be available as a modular item. As an example, assay cells according to the present invention may advantageously be incorporated into the ECL systems set forth in U.S. Pat. No. 5,061,445 (Zoski et al.), U.S. Pat. No. 5,147,806 (Kamin et al.), and U.S. Pat. No. 5,247,243 (Hall et al.) as well as in copending U.S. application Ser. No. _____ filed on even date herewith, and PCT Application No. _____ (WO _____) filed on even date herewith, both of which are incorporated by reference above.

[0056] In the following, each assay cell is shown containing a quantity of reagents which are labeled with the term "reagents". Such "reagents" include solid, liquid, and gaseous reagents, as well as solutions, suspensions, gels and other flowable states in which reagents may exist, combinations of any of the foregoing, and the like. Reagents may include the reagents required to perform an assay as well as a sample of unknown composition that is analyzed by an assay. Examples of suitable reagents and assay systems are found in copending U.S. application Ser. No. _____ filed on even date herewith, and PCT Application No. _____ (WO _____) filed on even date herewith, both of which are incorporated by reference above.

[0057] In a preferred embodiment, the sonication generator is structurally coupled to a solid-phase support at which binding reagents are located. In an especially preferred embodiment, the solid-phase support is an electrode capable of inducing an ECL moiety to luminesce. Preferably, the electrode comprises a fibril-polymer composite material.

[0058] **FIG. 1** illustrates a particular cross-sectional view of an assay cell **10** according to an embodiment of the present invention. Assay cell **10** comprises a base **11**, a diaphragm **13**, and a sonication generator **16**. Base **11** is shaped to define a cavity **17** and an aperture **14**, and is preferably a rigid material. Alternatively, base **11** comprises a flexible material (e.g., base **11** comprises a flexible plastic container or a blister pack). In assay formats that use optical detection techniques (e.g., ECL, fluorescence, chemiluminescence), base **11** is preferably a transparent material, such